PERFORMANCE OF CUP LUMP MODIFIED ASPHALT MIXTURE ALONG FEDERAL ROAD IN KEMAMAN, TERENGGANU

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DEDICATION

This work is dedicated to the sincerest,
Loving and caring parents,
My beloved Father and Mother,
Mohammad Najib bin Awang Kechik,
Muslimah binti Ibrahim,
My beloved Father and Mother in law,
Mat Ali bin Abdullah,
Wan Fatimah binti Wan Endok,
And my supportive wife,
Rosmaliza binti Mat Ali.
All my dear children,
Muhammad Naqib al baahiy, Muhammad Naufal al baahiy, Nuha Ajda and Muawiyyah.
Hopefully these efforts given consideration and rewarded by Allah.
As the Prophet Muhammad S.A.W said:
"Whoever follows a path to seek knowledge,
Allah will make the path to Jannah (Paradise) easy for them."
(Shahih Muslim)

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ABSTRACT

The temperature in Malaysia increased every decade and overload by heavy vehicle have created a permanent pavement deformation and shorten the pavement life. A lot of studies have been done by using different methods and material to improve the properties of conventional hot mix asphalt. Therefore, this study focused to identify the properties and performance of asphalt by using cup lumps modified asphalt (CMA). This study was conducted along federal road FT 237, sec. 26-29, Daerah Kemaman, Terengganu. This study has used 5 % Cup Lump Modified Binder (CMB). The tests that were conducted to determine the CMB performance were penetration test, softening point test, flash point and Marshall test. The result shows that by adding CMB into penetration grade 60/70 has reduced the penetration value and increased the softening point temperature. For Marshall properties, the performance of the CMA is better in terms of stability and stiffness compared to AC 10 and AC 14. Thus, it can be suggested that the performance of the CMA is better compared to the conventional asphalt mixture.

ABSTRAK

Peningkatan suhu di Malaysia setiap dekad dan kenderaan berat yang melibihi kapasiti telah menyebabkan berlakunya kerosakan jalan dan juga telah memendekan jangka hayat jalan. Terdapat beberapa kajian telah dilaksanakan bagi meningkatkan ciri-ciri turapan jalan dengan menggunakan pelbagai jenis bahan dan kaedah. Oleh itu, kajian yang dijalankan ini akan memberi tumpuan untuk mengenalpasti ciri-ciri dan prestasi turapan jalan dengan menggunakan *cuplump modified asphalt (CMA).* Kajian ini telah dijalankan di jalan Persekutuan FT 237, sek. 26-29, Daerah Kemaman, Terengganu. Campuran lima peratus (5%) cuplump modified binder (CMB) digunakan di dalam kajian ini. Ujian-ujian yang telah dijalankan bagi mengenalpasti prestasi CMB ialah ujian penusukan,titik lembut, titik kilat dan ujian marshall. Penggunaan CMB sebagai campuran kepada asphalt 60/70 telah menunjukkan penurunan nilai penusukan dan meningkatkan suhu di dalam ujian titik lembut. Ujian marshall menunjukkan prestasi CMA adalah lebih baik daripada *AC 10* dan *AC 14* dari segi kestabilan dan kekerasan. Oleh itu, prestasi CMA boleh dikatakan adalah lebih baik daripada campuran konvensional asphalt.

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LIST OF ABBREVIATIONS

CMB	-	Cup Lump Modified Binder
CLMB	-	Cup Lump Modified Binder
CLR	-	Cup Lump Rubber
PMB	-	Polymer Modified Binder
UMB	-	Unmodified Binder
CMA	-	Cup Lump Modified Asphalt
HMA	-	Hot Mix Asphalt
AC 10	-	Asphaltic Concrete 10
AC 14	-	Asphaltic Concrete 14
PWD	-	Public Works Department
BC	-	bituminous cup lump
mm	-	Millimeter
°C	-	Celsius
PI	-	Penetration Index
%	-	Percent
VTM	-	Voids in total mix
VFB	-	Void Filled with Bitumen
60/70	-	Penetration Grade 60/70
PG 76	-	Performance Grade 76
NRMA	-	Natural Rubber Mix Asphalt
NR	-	Natural Rubber

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CHAPTER 1

INTRODUCTION

1.0 Background of Study

Hot mix asphalt (HMA) is the most common type of asphalt mixture used in road construction. However, it has limitation of temperature, where it becomes softened when the temperature is high and crack when the temperature is low (Zainal *et al.*,2018). Nowadays, the global temperature in our country increase every decade. According to Intergovernmental Panel on Climate Change (IPCC), the average global land and ocean temperature increase 0.85 ˚C from year 1880 to 2012 (Kuok,2019).

In Malaysia, the temperature increases every decade and the annual mean temperature trend in Peninsular Malaysia recorded from year 1975 to 2006 showed an increment about 0.32 ˚C per decade (Chee et al, 2018). The other factor resulting the road defect such as cracking and surface deformation is the increasing of traffic volume with excessive load (E Shaffie et al, 2017). In order to increase the pavement life and overcome the road deformation or road damage, the properties of conventional Mix Asphalt (HMA) need to be improve.

1.1 Problem Statement

The normal hot mix asphalt AC 10 and AC14 have the limitation of temperature (Zainal *et al.*, 2018). The inability of unmodified bitumen to accommodate the rapid increase in heavy traffic loading and severe environment condition in road construction (S. Abdulrahman et. al., 2019). Increasing in the traffic volume, climatic condition and also construction design error will lead to the deformation of pavements which is rutting and it will cause large expenses for road maintenance (E Shaffie et.

al., 2017). The properties of normal hot mix asphalt (HMA) AC 10 and AC 14 need to improve to overcome the road deformation or road damage.

A lot of studies have been done by using different methods and materials to improve the properties of conventional hot mix asphalt, one of the methods was using modified asphalt. Therefore, this study focused to identify the properties and performance of asphalt by using cup lumps modified asphalt (CMA).

1.2 Aim and Objectives of Study

The aim of the study is to identify the properties and performance of asphalt by using cup lumps modified asphalt (CMA) along Federal Road in Kemaman, Terengganu. The main objectives to be archived in the research are as follows:

a) To determine the properties of Cup Lumps Modified Bitumen.

b) To investigate the performance of Cup Lumps Modified Asphalt mixture.

1.3 Scope of Research

This study is to identify the properties and performance of asphalt using cup lumps as a modifier. The properties of the CMB were measured on their penetration value, softening point and flash point and for the performance were measured by Marshall properties. The results have been compared to AC 10 and AC 14 based on Public Works Department (PWD) specification. The result only limited to the study location at federal road FT 237, sec. 26-29 in Kemaman, Terengganu.

1.4 Significant of Study

The cup lump modified asphalt (CMA) in road construction, is one of the alternatives done by the government to increase revenue of the rubber tapper in Malaysia. Furthermore, using the cup lump as a modifier in asphalt, it was expected to improve the AC 10 and AC 14 performance. The performance of cup lump asphalt was measured. The data and results from this study, can be used by other researcher or public departments to improve the quality of road pavement, then lengthen the life of pavement and reduce cost of maintenance in the future.

REFERENCES

Amin Shafii (2009). *Skid Resistance and The Effect of Temperature.*

Anas Ibrahim et. al. (2017). *Performance of Bituminous-Modified Binder Using Natural Rubber Latex as Green Enhancer.* Symposium on Innovation and Creativity (iMIT-SIC), Vol 1 (2017) pp 1-4.

Asphalt Mix Design (2004). *A guide to the process of Design and selection of an asphalt job mix*. Australian Asphalt Pavement Association (AAPA).

B.B TelTayev et. Al. (2019). *Evaluating the effect of asphalt binder modification on the low-temperature cracking resistance of hot mix asphalt.* Case Studies in Construction Material 11 (2019) e00238.

Chee et. al. (2018). *Trend Of Daily Rainfall and Temperature In Peninsular Malaysia Based On Gridded Data Set.* International Journal of GEOMATE, Vol.14, Issue 44, pp.65-72.

E Shaffie *et al.* (2017). *Rutting resistance of asphalt mixture with cup lumps modified binder*. IOP Conf. Series: Materials Science and Engineering 271 (2017) 012056.

Guilian Zou et. Al. (2017). *Evaluating of factors that affected rutting resistance of asphalt mixes by orthogonal experiment design.* International Journal of Pavement Research and Technology 10 (2017) 282-288.

JKR (2018) – *Ujian Makmal bitumen, aggregate, asphalt*. Public Work Department Malaysia.

Kuok (2019). *Climate Change In Malaysia: Trend, Contributor, Impacts, Mitigation and Adaptations.* Science of the Total Environment 650 (2019), 1858-1871.

Mazlina Mustafa Kamal et. Al. (2020). *Natural Rubber Modified Asphalt*. IOP Conf. Series: Earth and Environmental Science 498 (2020) 012001

Norfazira *et al.* (2019). *Engineering properties of asphalt binder modified with cup lump rubber.* IOP Conf. Series: Earth and Environment Science 220 (2019) 012014.

Norfazira et. al. (2019). *Mechanical Performance of Asphalt Mixture Containing Cup Lump Rubber.* Jurnal Teknologi (Sciences & Engineering) 81:6 (2019) 179-185.

R. Razali et. al. (2019). *Field Performance of Asphalt Pavement Maintenance Using Cup Lump Rubber Modified Asphalt (CMA).* IOP Conf. Series: Material Science and Engineering 527 (2019) 012064.

R Rahman *et al.* (2017). *The comparison of properties and cost of material use of natural rubber and sand in manufacturing cement mortar for construction sub-base layer.* IOP Conf. Series: Materials Science and Engineering 271 (2017) 012017.

R Utami *et al.* (2019). *Temperature Sensitivity Effect in Asphalt Modification with Natural Rubber sir20.* IOP Conf. Series: Material Science and Engineering 650 (2019) 012045.

S.Abdul Rahman et. al. (2019). *Physical Properties of Warm Cup Lump Modified Bitumen.* IOP Conf. Series: Material Science and Engineering 527 (2019) 012048.

SPJ (2008). *Standard Specification for Road Works – Section 4: Flexible Pavement*. Public Work Department Malaysia.

Zainal Othman et. al. (2018). *Cup Lump Modified Asphalt Mixture Along Jalan Kuala Lumpur – Kuantan, Daerah Termeloh, Pahang.* MATEC Web of Conference 250, 02007 (2018).

Zainab Ahmed (2018). *Effect of High Temperature and Traffic Loading on Rutting Performance Flexible Pevement.* Journal of King Saud University – Engineering Sciences 32 (2020) 1-4.

Zohair Ahmed (2016). *Modification of Asphalt Binder With Various Percentage of Crumb Rubber In Flexibility Pavement.*